Climatological Data for December, 1909.

DISTRICT No. 6, MISSOURI VALLEY.

J. WARREN SMITH, District Editor.

GENERAL SUMMARY.

December was one of the coldest months on record in the Missouri watershed, and the coldest December ever experienced over the greater part of the district. There were three main high pressure areas that dominated the conditions. The first appeared over the upper Rocky Mountain region on the 2d, the second moved from the North Pacific on the 14th, and the third moved from Manitoba almost directly south on the 28th and 29th.

Four well-defined low pressure areas moved across the southern part of the district from the lower Rocky Mountain region while only one large area came from the Northwest. This appeared over the upper Rocky Mountains on the 29th and caused comparatively mild weather in the upper watershed on that date and over the rest of the district on the 30th and 31st.

But from the time that the first cold wave appeared in the Northwest on the 2d until the northwestern depression exerted its moderating influence on the 29th the northern States experienced steady, cold weather, while the rises in temperature that spread over the southern States from the southwestern storms were of comparatively short duration.

The precipitation was very largely in the form of snow and was greater than usual in December. In most eastern States the snowfall was the greatest ever recorded in December. The ground was covered with snow throughout most of the month, because of frequent snowstorms, low temperature, and general lack of sunshine. In Montana the snow was fairly well packed in the mountains at the close of the month, but was not drifted. In Wyoming there was a good depth of snow over the State. In Colorado the snowfall was heavy and drifted badly. The snow storage conditions were good at the upper levels, but the snow was not well packed at the lower levels because of the intense cold.

Northwest winds prevailed. The wind movement was high in the mountains in Colorado, and the average daily velocity was slightly greater than the normal in Nebraska.

There was much more cloudy weather than is usual in this month.

The following information is from the reports of the Section Directors in each State:

Wyoming.—The month was one of the coldest Decembers on record, the greatest departures of the mean temperature from the normal being found at the lower valley stations. The lowest mean temperature was 5.8° at Basin, which is located at one of the lowest portions of the State at an elevation of about 3,800 feet, while the highest mean temperature was 20.2° at Granite Canon, which has an elevation of more than 7,300 feet. Chinook conditions prevailed over much of the State on the 1st, 30th, and 31st, but low temperatures obtained during most of the month. The precipitation was unevenly distributed, but over most of the State the snowfall was in excess of the normal. The continued cold weather prevented much melting of the snow, and the great depth remaining on the ground made the month one of the severest on range stock in the history of the State. In many districts where the stockmen had provided for winter feed it was found impossible to move stock to the feed, or to get the fodder to where the stock were ranging. The central and northern portions of the State suffered more than the southern portion in this respect. All stock have lost flesh rapidly and are not in good condition to stand further severe weather.

Montana.—The month was abnormally cold with nearly the usual amount of precipitation. It was the coldest December for 15 years over the State as a whole, the coldest previous to this being in 1902 when the mean was about 3° higher. The warmest section was immediately east of the Continental Divide. It was from 5° to 8° warmer in the upper parts of the Milk and Yellowstone River valleys than in the lower. The only extended period of mild temperatures was from the 11th to 16th, but this brought no marked chinook conditions, and very few days with the temperatures above freezing. The precipitation was somewhat in excess of the normal over the upper river valleys, but there was a deficiency over the larger part of the State. Practically all was in the form of snow. In most sections the ranges became covered early in the month and remained so till the close. Stockmen were at a disadvantage, but there was little loss of stock. Railroad traffic was somewhat delayed from the 5th to 7th on account of drifting snow and extremely cold weather. The wind movement was below the normal except at Havre. There was more snow than usual in the Gallatin and Bridger mountains in the Gallatin drainage basin at the close of the month. The snow was not drifted so much as usual, and while the drifts were mostly compact they were not solid from freezing and thawing. Snow accumulated to the depth of several feet at high altitudes in the Jefferson drainage basin. The December fall was above the average. There was 6 to 10 feet of snow above 8,000 feet elevation in the Madison drainage basin. The snowfall was above the average here, and heavier as a rule than in 1908. In the Musselshell drainage basin the December snowfall was deficient in the Judith, Crazy, and Snowy mountains, but was above the normal, as a rule, in the Little Belt and Castle ranges. The snow in many sections was solidly packed, and the drifts thickly crusted from thawing and freezing. From 2 to 4 feet of snow lay on the ground above 7,000 feet elevation in the Sun River drainage basin, and the drifts were fairly compact. There was more snow generally over the upper Yellowstone drainage basin than at the close of December, 1908. The snowdrifts were well packed, but not icy. The ground was moist and frozen under the snow in most of the mountain districts.

North Dakota.—The weather during the month was cold, stormy, and disagreeable. The mean temperature was nearly 10° below the normal and was the lowest ever recorded, except in 1893. The precipitation was 0.61 inch above the normal and, except on the 1st and 2d, was all in the form of snow. The snowfall was the heaviest ever recorded during any December since this service was established in 1892. Owing to the heavy snowfall there was considerable delay in traffic, and the abnormally low temperatures made the work of opening the highways doubly difficult. Live stock suffered greatly owing to the heavy snowfall and intense cold combined. All elements considered, the month was the severest in the history of the climatological service in the State. There was less than the usual amount of sunshine, and as few temperatures above the freezing point were recorded, much snow remained on the ground at the close of the month.

South Dakota.—The weather, on the whole, was very unfavorable for all kinds of outdoor work. The temperature averaged the lowest for December in 20 years. Compared with the 19 preceding years, there has been none with a lower maximum and only 6 with a lower minimum in December. The precipitation was about 1.10 inch above the normal and was the greatest for December in 20 years. The snowfall averaged 15.6 inches and amounted to 59.3 inches at the Hardy Ranger Station in the Black Hills, at an elevation of 6,600 feet. Snow occurred frequently but there were no specially heavy falls, except in parts of the Black Hills district on the 11th. The depth of snow on the ranges, which are usually in suitable condition for winter grazing in December, caused some suffering to live stock and necessitated much unexpected feeding. Owing to the cold weather and drifting snow the railroads in all parts of the State experienced much delay in operating trains, especially freight, and in several instances passenger trains were temporarily suspended. The wagon roads were so bad also that the receipt of grain at the elevators was much less than usual for this month. The month closed with much corn remaining in the fields. Outside mining, prospecting, and development work in the Black Hills district was practically suspended. There was much less than the normal amount of sunshine.

Colorado.—The month was remarkable for the steady and severe cold, and the mean temperature for the State was the lowest ever recorded; the lowest previous mean was in February, 1903. The mean for the northeastern portion was 11.7° below the normal. The deficiencies were somewhat less at the higher levels than at the lower. The deficiency in the day temperatures was greater than that in the night temperatures. The amount of temperature inversion, which usually accompanies cold spells, was less than usual. The precipitation was slightly above the normal. The snowfall was heavy throughout the greater part of the mountains; at the close of the month its condition was generally good at the higher levels, but lower it was not well packed, owing to the excessive cold. There was much drifting of the snow and the mountain passes were blocked for considerable intervals. Very considerable loss resulted from the severe cold. Railroad traffic was maintained with difficulty, and at heavy expense.

Nebraska.—This was the coldest December ever recorded at most stations in Nebraska. The mean temperature averaged more than 12° below the normal and was 7° below the normal for January and 10° below the normal for February. The month was one of the 10 coldest months, including January and February, during the past 35 years. The precipitation was 1.19 inches above the normal. The snowfall was the greatest ever recorded in December. The wind was light and the snow did not drift at all badly; nevertheless the snow and low temperature interfered somewhat with transportation. All trains were delayed more or less, but none of the main lines were seriously blocked. On the branch lines, in some instances, the trains were

blocked for 1 or 2 days. The street cars in both Omaha and Lincoln were much inconvenienced and cars ran irregularly on many days. The first fall of snow occurred early in the first week and the ground was covered practically all the month. Some loss of stock has resulted, although most men have been feeding regularly. This has caused a decided rise in the price of feed, especially hay. The severe weather greatly retarded all building operations; usually this work can be continued during most of December. The average wind velocity was about 0.3 mile above the normal.

Iowa.—December, 1909, will be noted for its low temperature, excessive cloudiness, and the frequency of snowstorms. It was the coldest December since State-wide observations began in 1890, and probably the coldest since 1876. The weather was almost continuously cold from the 3d to the last day of the month. The precipitation was above the normal and was mostly in the form of snow after the 5th. The snowfall, although of frequent occurrence, was generally light, except on the 24th. The fall was from 5 to 13 inches on this date and all freight trains and Christmas passenger traffic were delayed, although no trains were stalled. A sleet occurred on the 4th, which covered the ground with a thick coating of ice and made a good foundation for the snow that followed, and excellent conditions for sleighing. The heavy snow and severe cold weather put a stop to all drainage work,and has prevented the belated corn harvest. Much of the corn is lying on the ground and is covered with ice and snow. On account of not being able to turn stock into the fields where the corn is not yet gathered, farmers have been obliged to feed more hay than usual. The snow has furnished a good blanket for the protection of meadows, alfalfa, and winter grains, all of which are reported to be in excellent condition.

Kansas.—The month was cold, cloudy, and wet. It was the coldest December on record. The temperature was above the normal on the first 3 and last day of the month, but below the normal the rest of the time. The average precipitation, 1.70 inch, has seldom been equaled, and was 0.92 inch above the normal. There was a slight deficiency, however, over part of the headwaters of the Solomon and Smoky Hill rivers. The precipitation occurred principally during the first week and from the 22d to 24th. There was a general sleet storm on the 4th, which, in the eastern counties, was accompanied by much thunder. From 4 to 8 inches of snow fell on the 6th, making a protection for the wheat from the cold weather that followed. More snow fell on the 24th, making from 8 to 15 inches of snow for the month. The snow has seriously interfered with corn gathering. The sleet and snow materially interfered with traffic by railroad, interurban lines, and wagon roads, and some damage was done to perishable goods by the enforced delays

Missouri.—This was the coldest December of which there is any authentic record. The month was remarkable rather more for its low and stable mean temperatures than its minima. There were 3 zero periods in the Ozark region and 4 north of the Missouri River. The precipitation was uniformly distributed and was generally in excess of the normal. After the 5th all precipitation was in the form of snow or sleet. Snow was continuously on the ground from the 5th to 30th inclusive. Transportation was impeded and for short periods suspended. The cold weather had a favorable effect on the dry goods and clothing business, but was rather unfavorable to commission and railroad shipments, as perishable goods could not be handled during a considerable part of the month. Wheat entered the winter in excellent condition and was well protected by snow in December. The month was unfavorable for outdoor work, but favorable for outdoor sports. Sleighing and skating were the finest in many years and were continuous for 3 weeks. There was a marked deficiency in the sunshine. The relative humidity was about 6 per cent higher than the average.

TEMPERATURE.

This was the coldest December ever recorded in practically all parts of the Missouri watershed. In the northwestern States the first and last 3 days were comparatively mild, and in the southeastern States the first 3 and last 1 or 2 days were warm. Cold weather prevailed during the balance of the month. The highest temperature recorded was 78° at Fort Morgan, Colo., on the 31st, at an elevation of 4,319 feet above sea level. The maximum was above 50° in all of the States and 60° or above in all but Montana, North Dakota, and Iowa. The minimum temperature was −38° at Grayling, Mont., on the 17th. The minimum was lower than −20° in all of the States, except Missouri and Kansas.

PRECIPITATION.

The precipitation was above the normal, except in parts of the upper watershed. It was heaviest on record for December in South Dakota. The greatest amount for the month was 6.17 inches at Sublett, Mo. The greatest fall in any 24 hours was 2.75 inches at Sublett on the 4th. Most of the precipitation was in the form of snow and in some of the eastern States in the district the snowfall was the heaviest ever recorded in December. The greatest snowfall was 59.3 inches at Hardy Ranger Station, S. Dak. The snowfall was over 2 feet at some stations in each State, except in Kansas and Missouri. The cold weather and lack of sunshine caused the snow to remain on the ground during practically all of the month in all districts.

RIVERS.

The small tributaries of the Gallatin and Madison rivers in Montana carried more than the normal flow of water. The main stream and many of the tributaries of the Yellowstone were at a lower stage than usual. The flow of the Missouri River at Helena was about normal. The principal streams in South Dakota were frozen over early during the month. In Kansas the different rivers froze over between the 4th and 7th and remained frozen during the month, except that the Kansas River was open from the 14th to 20th.

Floating ice appeared in the Missouri at St. Joseph, Mo., on the 4th, at Kansas City on the 7th, at Hermann on the 9th, and in the Mississippi at St. Louis on the 10th. Heavy ice was running at Kansas City on the 9th and gorges formed on the 17th. During the last week of the month the river was practically frozen over at Kansas City, there being only small areas of open water. Navigation was suspended at St. Louis on the 16th, except the movement of ferry boats, and on the Missouri River at Hermann on the 18th. The Terminal Transfer boats operated at St. Louis until the 29th.

An ice gorge was reported in the Mississippi River near Chester, Ill., on the 22d. This held the ice floes, and the gorge gradually built up stream until the local harbor at St. Louis was filled on the last day of the month. Other gorges formed above the city, and, starting down with the rise in water on the 31st, the ice carried out the false work at the McKinley bridge at St. Louis. There was no loss of life, but the damage to the structure was considerable, and several months delay will occur in the completion of the work.

Work at the Holter dam in the Missouri River in Montana was seriously interfered with by floating ice. Work on the bridge at Kansas City was suspended near the close of the month as the barges could not be kept in the river because of the floating ice.

The division engineer of the Missouri Pacific Railway Company reports that their river protection work on the Missouri River between St. Louis and Kansas City was stopped because of unfavorable conditions. The first part of the month there was so much floating ice in the river that barges and small craft could not be handled and later in the month the river was frozen too much for work.

MISCELLANEOUS.

A number of large private irrigation projects are being planned for Montana, the work to be begun next summer. One near Dillon contemplates the irrigation of about 80,000 acres, and permits have been issued for reservoirs in the Jefferson forest reserve on the Musselshell River that will irrigate over 30,000 acres.

The ice on the rivers and ponds froze to an unusual thickness for this month and good crops of ice were harvested, even as far south as Missouri.

There was a pronounced shortage of natural gas in western Missouri and eastern Kansas with the storm and cold wave on the 6th. The schools were closed at St. Joseph, Mo.

Plans are being carried out for the completion of the straightening of the Nishnabotna River in western Iowa and Missouri. This ditch starts in Carrol County, Iowa, and will extend for about 100 miles when entirely completed.

Work in connection with washing away of excavated material with the use of a pump and long pipe was suspended at St. Mary Reclamation Project in Montana on the 10th because of unfavorable weather. Work was suspended also at the Huntly and Sun River projects because of the cold and the freezing of the ground. At the Belle Fourche Project in

South Dakota nothing could be done on the great dam, and it was with the greatest difficulty that any work could be kept open.

The forest supervisor of the San Isabel forest reserve in Colorado reports that snow fell almost continuously from December 1 to January 3. Logging, examination of claims, etc., were interfered with. The supervisor of the Arapaho forest states that for a period of over a week during the middle of the month the temperature fell each morning to −38° to −48° while the lowest registered was −60°. The supervisor of the Las Animas National Forest at La Veta, Colo., states that the total snowfall at the upper ranches near the Spanish Peaks and the upper Cucharas is now 78 inches. Considerable of this has drifted into the canyons where it is freezing and getting solid. The heavy snowfall accompanied by an occasional wind has caused all roads, trails, and even the open fields to be impassible for all travel, except snow shoes, on at least two-thirds of the forest. The cutting of timber either under free use permit or sale has been entirely stopped on account of the severe weather conditions.

The Horticulturalist of the Experiment Station at the University of Missouri, Prof. J. C. Whitten, has sent the following very important letter regarding the possible damage to fruit buds because of the severe weather in December following the unusually mild and wet November:

> We have been making a very careful examination of the buds on our experiment station grounds since this cold spell, and I am glad to report that thus far they remain practically uninjured. Of course, our peach trees set many times as large a number of fruit buds as are needed for a full crop of fruit. In any weather, no matter how favorable, some percentage of these fruit buds will be killed or weeded out by weather conditions.
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> The last observation which we made, January 4, showed that not more than 5 per cent of the fruit buds of hardy varieties have been killed this winter, and only 15 per cent of the tenderest varieties, like Alberta, have been killed. This is a smaller percentage of fruit buds than are usually killed up to this time, even in our most favorable winters. I would have to say then that at the present writing there has been less injury to fruit buds of all kinds on our experiment station grounds this winter than has ever before been the case at this time of year during the 15 winters that I have been at Columbia.

THE UNITED STATES WEATHER BUREAU IN THE WORK OF THE ENGINEER.

J. A. OCKERSON.

The engineer engaged in works for the improvement of the navigation of streams, the control of floods, or the drainage of lands is always deeply interested in precipitation records as reflected in the stage of streams, the run-off of a given watershed, or low temperatures which may result in ice.

In planning construction work of any kind within the high water banks of a stream, the engineer speculates on the probable date when the stage of the river will be such as to enable actual work to begin and how long a season of suitable stage he may reasonably expect. He must also reckon with the temperature conditions which produce ice, the probable duration thereof, and the months between November and March, when it is most liable to occur.

In dredging for the maintenance of low water channels the engineer gives consideration to the stages of the contributing tributaries in order that he may approximate the time when actual work should begin; and near the end of the low water season he studies the increase in stage and causes thereof in order to determine whether or not higher stage conditions are to be permanent. The date of the return of the dredges to winter quarters depend on this decision.

In the construction of levees for flood control study is given to the probable crest of a coming flood from the time it starts at the headwaters of the tributary streams, and the work is shaped as far as practicable so that the new embankment may not be overtopped and seriously damaged.

Before the drainage engineer can reach an intelligent conclusion as to the size of ditches required in a given district he must study carefully all available records as to rainfall and run-off in the area to be drained.

The irrigation engineer in the same way arrives at the amount of water which he can probably store for use during the dry season.

Railway engineers must know areas of watersheds, the maximum rainfall, and run-off in order to determine the size of culverts required to safely pass flood volumes.

The city engineer must be acquainted with similar facts in order to design sewers that will be of sufficient size to carry off surface drainage due to rainfall.

So it will be seen that the observations of the Weather Bureau touch the work in all branches of engineering, and reliable records of rainfall and temperature are of great value to the engineer.

It is important that such records be continued and that the number of stations be increased so that more rainfall measurements would be available for use in predicting stages in the streams of the minor basins.

It would also be well if attention could be given to run-off, especially in cases of rainfall of unusual magnitude.

The field of work occupied by the United States Weather Bureau is of great importance and value to the engineer, and as such it has won the confidence of the profession at large and is entitled to the assistance and support thereof.